a distinct line of inquiry. In framing his own answer to the question, the author lays stress on the controlling power of heredity, on Darwin's principle of "continuity of variation," or, as he prefers to call it, "sequence of variation," and also on the fact that the variations of the organic environment of a species—the several other species, that is to say, with which it has to keep *en rapport*—being subject to similar limitations with its own, are not likely to set it an impossible task in the way of providing fresh adaptations. Moreover, there are usually periods in the history of a species when it has, as it were, a choice of environments, so that the possibilities of adaptation open to it are enlarged. This latter position might well have been illustrated by the striking case of certain mimetic butterflies; amongst which it is often found that species closely allied to one another, and sometimes even the two sexes of the same species, have been drawn apart, so to speak, into separate protected colour-groups; while still other species of the same affinities occupy intermediate positions, ready, as it were, to throw in their lot with this or that colour-combination, according to their needs. The upshot of the author's contention as to variation and adaptation is, that while the range of possible variation is not indefinite, but necessarily limited, the limitation is in no sense due to the direct action of the environment; still it is this very limitation that renders adaptation possible, by ensuring a supply of such material as is capable of being moulded by the selective action of the existing external conditions. Variation that took place merely at random, were it conceivable, would almost inevitably consist of all misses and no hits.

In the second and concluding part of the book, Mr. Headley deals with the application of evolutionary doctrine to the problems of human development. His treatment of this part of the subject, as of the other, shows freshness, vigour and ability; but he could here hardly avoid raising points of a highly controversial character, and most of his conclusions are likely to be sharply assailed. Adopting in many respects the point of view of Mr. Benjamin Kidd, he discusses at length the origin and influence of the moral sense, and the various conditions that with advancing civilisation tend to defeat or delay the operation of natural selection. The antagonism between altruism and the "cosmic process," which was adumbrated by Huxley in his memorable Romanes lecture, receives a careful and extended treatment; and the author states his own conclusion somewhat as follows:—The development of human intelligence has in many ways checked the wholesome operation of natural laws. Being capable of exercise in anti-social directions, it has in times past threatened the well-being if not the very existence of the race. From this fate humanity has so far been preserved by the practice of altruism under the sanctions of religion and morality. Supposing this first peril to have been successfully met, there remains the further danger of physical degeneration, which may presently become imminent, and the proper treatment of which is among the most important problems that await us. In spite of his indictment of human reason, Mr. Headley is no pessimist. So far from having lost confidence in the future of the race, he looks boldly to the old sanctions, under higher and more enlightened forms of application, to save the human species from physical, as they already have from social disintegration. It is obvious that the working out of this idea, which indeed is not attempted by the author himself in any detail, involves considerations which are unsuitable for discussion in a notice like the present. Suffice it to say that Mr. Headley does not write at random; and that his views challenge attention, whether sympathetic or otherwise.

Notwithstanding an occasional abruptness and jerkiness of style, the author writes well and expresses his views with clearness. More care might with advantage have been bestowed on the proofs; misprints are not uncommon, the punctuation frequently leaves much to be desired, and there is a curious lack of uniformity in the use of scientific names. Some questionable palæontology will be found on p. 105, and some equally doubtful pathology on pp. 246, 247. An inaccurate use of the term "chrysalis" may be noted on p. 59. But in spite of these and other failings the book reaches a high standard of merit, and should appeal to a wide circle of general readers besides those more especially conversant with the subjects of which it treats. F. A. D.

THE CENTURY OF SCIENTIFIC PROGRESS.

The Story of Nineteenth Century Science. By Henry Smith Williams, M.D. Pp. x + 476. Illustrated. (London and New York: Harper and Brothers, 1900.) Price 9*s*.

THE story is worth telling, for whatever the ages may hold in store they can hardly deprive the nineteenth century of the distinction of having witnessed a progress in science without a parallel in the earth's history. Each step in advance has served as a starting-point for many others, and the record of the last quarter century, even of the last decade, far surpasses that of the corresponding period at the outset. The opening chapter of this book, "Science at the Beginning of this Century," enables us to realise how immense the gain has been.

To write such a history is a task on which, at the beginning of the century, an author might have entered with a light heart. Now such an undertaking seems almost an audacity. Scientific omniscience has long become impossible; but in an age of such rapid progress something of the kind is required for a work like this. The reviewer is in a still worse plight. How can he—probably almost wholly occupied in trying to carry some one road a little farther into the unknown land—be competent to decide whether the author has done full justice to those similarly engaged in other directions? So I shall speak critically only of my particular subject, and for the rest briefly touch upon the salient features in the author's narrative. The book, I may remark, evidently had its origin on the other side of the Atlantic, so that the illustrations have a slightly American tinge. The same also may sometimes be said of the English. As example, "down" is a new verb to us; "per hypothesis" jars on the ear; to say that a man was "then only a novitiate in science," startles any one accustomed to employ the word novice. Such solecisms, however, are but few. The chapter on palæontology seems oddly placed between

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those on astronomy and geology—surely this, as regards the latter, is a "cart before horse" position. It is also widely separated from biology, with which it is no less closely connected.

We turn, then, to geology, which a century ago could hardly claim to be a science. We find a clear sketch of the principal advances, with some particulars about those who made them, and only in a very few cases are we inclined to dissent. To say that the "strata are level" in the mountains of Sicily [and] the Scotch Highlands is doubtful, unless we are rather liberal in using the term mountain, and is true of only a small portion of the latter region. In speaking of the joint work of Murchison and Sedgwick, the author fails to mention the Cambrian system, and thus does an injustice to the man who independently and accurately established its position. In regard to the Laurentian system, we think that the statement "they are now more generally regarded as once-stratified deposits metamorphosed by the action of heat" would have been truer twenty years ago than at the present time, for the majority of these rocks, we think, are now more commonly considered to have had an igneous origin. While we believe, with the author, that uniformitarian creed must not be so enunciated as to exclude a certain "slowing down," we should hesitate to assert that in any known era

> "large areas were rent in twain and vast floods of lava flowed over thousands of square miles of the earth's surface, perhaps at a single jet; and, for aught we know to the contrary, gigantic mountains may have heaped up their contorted heads in cataclysms as spasmodic as even the most ardent catastrophist of the elder day of geology could have imagined."

But with a crust much thinner than it has been in later geological ages, fracture would be more easy and catastrophic disturbances less intense, because more frequent. At any rate, the facts of geology, so far as we can remember, do not support this statement, and Lord Kelvin, who is quoted in its favour, once used the simile of the last spurt of a cooling porridge pot to indicate that, owing to the greater resistance of the crust, a local catastrophe might be as severe in a late age as in an early one. Again, we demur to the following statement—if the author is speaking of any known geological age—that the constituents of the early atmosphere "have since been stored in . . . granite." Unless we admit it to have cooled on the earth's surface, how could this rock plunder the atmosphere? But *Ubi plura nitent . . . paucis offendar maculis?* The author gives a clear sketch of the progress of geology and palæontology from infancy to adult manhood. The principal stages of growth are described, even youthful escapades, the age of which is not yet ended, are sometimes chronicled. But for the most part he restricts himself to those hypotheses which have been able to stand the test of time and are now more or less promoted to the dignity of theories.

But the advances in terrestrial and celestial physics have been even more surprising. With the spectroscope to investigate and the camera to record, each being a discovery of this century, sun, stars, comets and nebulæ are yielding up their secrets; the existence of the ether, the nature of light, the relations of the physical forces, are demonstrated—nay, the genesis of worlds and of matter itself are becoming themes for discussion, while immense advances have been made in chemistry and meteorology. The same is true of the biological sciences, which have been almost revolutionised since the appearance of the "Origin of Species," little more than forty years ago. Though, as these pages prove, no one would assert that the last word has been said on evolution, the process, however it may be explained, is a fact, and its consequences have already extended far beyond biology.

The advance is not yet ended. In proof of that we need only point to the marvels of the Röntgen and Becquerel rays—discoveries of the last decade. Problems enough await solution in this century, of which an excellent summary will be found in the concluding chapter. Unless some dark catastrophes await civilisation, like that triumph of savage ignorance which boasted that "the republic has no need of *savants*," many secrets of nature should be discovered before the new century has run its course. Matter, force, energy, life—what problems these four words suggest, perhaps in part inscrutable—but still, even of these our descendants should know more than the wisest of our own age.

Dr. Williams has produced an interesting book, the more so because it is liberally illustrated with portraits of the leaders of science. These, though unpretending, are often good likenesses, the other illustrations being of a more commonplace character. This volume, like White's "Warfare of Science," should be a manual in every course of theological instruction, because the history of the progress of science declares how it has been opposed, in the imaginary interests of religion, by the friends of the latter. In the past the geologist, the biologist, the physiologist have been vituperated and denounced by ignorant champions of theology, whose fears and assertions time has proved equally unfounded. The mistakes of their forefathers will be a lesson of caution to coming generations; for the spirit of ecclesiasticism is not yet extinct, and our successors will have to confront old foes, though perhaps with new faces.

T. G. BONNEY.

VAN 'T HOFF'S PHYSICAL CHEMISTRY.

Lectures on Theoretical and Physical Chemistry. By J. H. van 't Hoff. Translated by R. A. Lehfeldt. Part iii. Relation between Properties and Composition. Pp. 143. (London: Edward Arnold, no date.)

Leçons de Chimie Physique. Par J. H. van 't Hoff. Ouvrage traduit de l'allemand par M. Corvisy. Troisième partie. Relations entre les Propriétés et la composition. Pp. ii + 170. (Paris: A. Hermann, 1900.)

THE English and French translations of the concluding part of van 't Hoff's lectures are now before us. Although this part ostensibly deals with the relations between properties and composition, its scope is really wider than its title, for it includes the discussion of colligative properties, which are not related to composition at all.

The first third of the book is chiefly concerned with volume, pressure and temperature relations as deduced from van der Waals's equation and the critical constants. As a feat of terse and lucid exposition, this section is unequalled in any text-book with which the present

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